## REPORT DOCUMENTATION PAGE

Form Approved OMB No. 0704-0188

	امتامك مممود والمستدالة	ing the time for review	ing instructions, searching data sources,	
	is estimated to average 1 hour per response, included the string and reviewing the collection of information. Ser		ring instructions, searching data sources, ig this burden estimate or any other aspect of this collection perations and Reports,	
Public reporting burden for his collection of anotheracting gathering and maintaining the data needed, and comple of information, including suggestions for reducing this b 1215 Jefferson Davis Highway, Suite 1204, Afrington, V Paperwork Reduction Project (0704-0188) Washington,	urden to Washington Headquarters Service, Difectol (A. 22202-4302, and to the Office of Management ar	nd Budget,	• • • • •	
Paperwork Reduction Project (0704-0188) Washington, PLEASE DO NOT RETURN YOUR FOR	DC 20503.			
1. REPORT DATE (DD-MM-YYYY)	12. REPORT DATE	-	3. DATES COVERED (From - To)	2002
31-12-02	Final		03-01-2002 - 12/31/	2002
4. TITLE AND SUBTITLE		5a.	CONTRACT NUMBER	
4. IIILE AND SOBTILL				
		5h	GRANT NUMBER	
North Pacific Whale Calling Program		35.	N00014-02-1-0328	
			TATAL MUMPED	
		5c.	PROGRAM ELEMENT NUMBER	
		1		
		5d	. PROJECT NUMBE	
6. AUTHOR(S)		الا	WHOI proj. # 13032800	
William A. Watkins		5e	5e. TASK NUMBER	
		1		
		5f.	5f. WORK UNIT NUMBER	
			8. PERFORMING ORGANIZATION	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)			REPORT NUMBER	
			NEI ON TOWN	
Woods Hole C	Oceanographic Institution			
77 00 db 11010 1				
				_
9. SPONSORING/MONITORING AGEN	ICY NAME(S) AND ADDRESS(ES)			
0. 0. 0				
		<i>•</i>	20020210 011	<b>n</b>
OM		$\tilde{z}$	20030312 271	ገ .
ONR		2	20030312 240	)
ONR		2	20030312 240	•
			20030312 240	
ONR  12. DISTRIBUTION AVAILABILITY ST	ATEMENT			<u> </u>
	ATEMENT			) -
	ATEMENT		20030312 240	)
12. DISTRIBUTION AVAILABILITY ST	ATEMENT			) - 
	ATEMENT			<u> </u>
12. DISTRIBUTION AVAILABILITY ST	ATEMENT			]
12. DISTRIBUTION AVAILABILITY ST  13. SUPPLEMENTARY NOTES	Approved for public	c release —	distribution unlimited	
12. DISTRIBUTION AVAILABILITY ST  13. SUPPLEMENTARY NOTES	Approved for public	c release — (	distribution unlimited  US hydrophones has continued to properties.	rovide
12. DISTRIBUTION AVAILABILITY ST  13. SUPPLEMENTARY NOTES  14. ABSTRACT This seventh years and data on the consolution.	Approved for publication of monitoring calling what	c release — c	distribution unlimited  US hydrophones has continued to proper the second of the secon	rovide
12. DISTRIBUTION AVAILABILITY ST  13. SUPPLEMENTARY NOTES  14. ABSTRACT This seventh ye good data on the season	Approved for publication of monitoring calling what all distribution blue, fin, and heavened of approach movements.	c release – o	distribution unlimited  US hydrophones has continued to putales across the North Pacific. The tal variability, and changes in call	rovide
12. DISTRIBUTION AVAILABILITY ST  13. SUPPLEMENTARY NOTES  14. ABSTRACT This seventh ye good data on the season data have allowed assess	Approved for public Approved for public ar of monitoring calling what all distribution blue, fin, and he sement of annual movements,	c release — ces via SOSU	distribution unlimited  US hydrophones has continued to pure the properties of the North Pacific. The tal variability, and changes in callents of calling components of the	rovide
12. DISTRIBUTION AVAILABILITY ST  13. SUPPLEMENTARY NOTES  14. ABSTRACT This seventh ye good data on the season data have allowed assess features. These data de	Approved for public ar of monitoring calling what all distribution blue, fin, and has monstrate (1) the occurrence points in the offshore waters are	des via SOSU numpback whenvironment and movements	distribution unlimited  US hydrophones has continued to pure the properties of the North Pacific. The tal variability, and changes in call ents of calling components of the th Pacific, (2) the changes in these	rovide
12. DISTRIBUTION AVAILABILITY ST  13. SUPPLEMENTARY NOTES  14. ABSTRACT This seventh ye good data on the season data have allowed assess features. These data de	Approved for public ar of monitoring calling what all distribution blue, fin, and has monstrate (1) the occurrence points in the offshore waters are	des via SOSU numpback whenvironment and movements	distribution unlimited  US hydrophones has continued to pure the properties of the North Pacific. The tal variability, and changes in call ents of calling components of the th Pacific, (2) the changes in these	rovide
12. DISTRIBUTION AVAILABILITY ST  13. SUPPLEMENTARY NOTES  14. ABSTRACT This seventh ye good data on the season data have allowed assess features. These data de populations of these specifications of these specifications are serviced numbers.	Approved for public ar of monitoring calling whal hal distribution blue, fin, and hasment of annual movements, monstrate (1) the occurrence ecies in the offshore waters according whales (3) the	des via SOSU numpback when vironment and movem cross the Norce	distribution unlimited  US hydrophones has continued to pure the properties of the North Pacific. The tal variability, and changes in call ents of calling components of the th Pacific, (2) the changes in these of calling with known features of	rovide
12. DISTRIBUTION AVAILABILITY ST  13. SUPPLEMENTARY NOTES  14. ABSTRACT This seventh ye good data on the season data have allowed assess features. These data de populations of these specific properties of the estimated number appropriate of the service of the s	Approved for publication of monitoring calling what all distribution blue, fin, and has monstrate (1) the occurrence exists in the offshore waters according whales, (3) the object of offshore of offshore waters of offshore	les via SOSU numpback when and movem cross the Nor correlation core whale ca	distribution unlimited  US hydrophones has continued to pure hales across the North Pacific. The tal variability, and changes in call ents of calling components of the th Pacific, (2) the changes in these of calling with known features of lling, and (5) tracks for individual	rovide
12. DISTRIBUTION AVAILABILITY ST  13. SUPPLEMENTARY NOTES  14. ABSTRACT This seventh ye good data on the season data have allowed assess features. These data de populations of these specific properties of the estimated number appropriate of the service of the s	Approved for public ar of monitoring calling whal hal distribution blue, fin, and hasment of annual movements, monstrate (1) the occurrence ecies in the offshore waters according whales (3) the	les via SOSU numpback when and movem cross the Nor correlation core whale ca	distribution unlimited  US hydrophones has continued to pure hales across the North Pacific. The tal variability, and changes in call ents of calling components of the th Pacific, (2) the changes in these of calling with known features of lling, and (5) tracks for individual	rovide
12. DISTRIBUTION AVAILABILITY ST  13. SUPPLEMENTARY NOTES  14. ABSTRACT This seventh ye good data on the season data have allowed asses features. These data de populations of these spe (3) the estimated numb population activities, (4 whales. These have all	Approved for publication of monitoring calling what all distribution blue, fin, and has monstrate (1) the occurrence exists in the offshore waters according whales, (3) the object of offshore of offshore waters of offshore	les via SOSU numpback when and movem cross the Nor correlation core whale ca	distribution unlimited  US hydrophones has continued to pure hales across the North Pacific. The tal variability, and changes in call ents of calling components of the th Pacific, (2) the changes in these of calling with known features of lling, and (5) tracks for individual	rovide
12. DISTRIBUTION AVAILABILITY ST  13. SUPPLEMENTARY NOTES  14. ABSTRACT This seventh ye good data on the season data have allowed assess features. These data de populations of these specific properties of the estimated number appropriate of the service of the s	Approved for publication of monitoring calling what all distribution blue, fin, and has monstrate (1) the occurrence exists in the offshore waters according whales, (3) the object of offshore of offshore waters of offshore	les via SOSU numpback when and movem cross the Nor correlation core whale ca	distribution unlimited  US hydrophones has continued to pure hales across the North Pacific. The tal variability, and changes in call ents of calling components of the th Pacific, (2) the changes in these of calling with known features of lling, and (5) tracks for individual	rovide
12. DISTRIBUTION AVAILABILITY ST  13. SUPPLEMENTARY NOTES  14. ABSTRACT This seventh ye good data on the season data have allowed asses features. These data de populations of these spe (3) the estimated numb population activities, (4 whales. These have all	Approved for publication of monitoring calling what all distribution blue, fin, and has monstrate (1) the occurrence exists in the offshore waters according whales, (3) the object of offshore of offshore waters of offshore	les via SOSU numpback when and movem cross the Nor correlation core whale ca	distribution unlimited  US hydrophones has continued to pure hales across the North Pacific. The tal variability, and changes in call ents of calling components of the th Pacific, (2) the changes in these of calling with known features of lling, and (5) tracks for individual	rovide
12. DISTRIBUTION AVAILABILITY ST  13. SUPPLEMENTARY NOTES  14. ABSTRACT This seventh ye good data on the season data have allowed asses features. These data de populations of these spe (3) the estimated numb population activities, (4 whales. These have all	Approved for publication of monitoring calling whale all distribution blue, fin, and has ment of annual movements, monstrate (1) the occurrence excises in the offshore waters access of calling whales, (3) the experience of the annual patterns of offshowed good forecasts for the o	des via SOSU numpback when vironment and movem cross the Nor correlation correlation correlations correlations and correlations	distribution unlimited  US hydrophones has continued to propose across the North Pacific. The tal variability, and changes in call ents of calling components of the th Pacific, (2) the changes in these of calling with known features of lling, and (5) tracks for individual ese strong biological noises.	rovide
12. DISTRIBUTION AVAILABILITY ST  13. SUPPLEMENTARY NOTES  14. ABSTRACT This seventh ye good data on the season data have allowed asses features. These data de populations of these spe (3) the estimated numb population activities, (4 whales. These have all 15. SUBJECT TERMS	Approved for public ar of monitoring calling what all distribution blue, fin, and has monstrate (1) the occurrence exies in the offshore waters access of calling whales, (3) the howed good forecasts for the o	des via SOSU numpback when vironment and movem correlation correlations which is a number   192	distribution unlimited  US hydrophones has continued to purchales across the North Pacific. The tal variability, and changes in call ents of calling components of the th Pacific, (2) the changes in these of calling with known features of lling, and (5) tracks for individual ese strong biological noises.	rovide ese e calls,
12. DISTRIBUTION AVAILABILITY ST  13. SUPPLEMENTARY NOTES  14. ABSTRACT This seventh ye good data on the season data have allowed asses features. These data de populations of these spe (3) the estimated numb population activities, (4 whales. These have all 15. SUBJECT TERMS	Approved for public ar of monitoring calling what all distribution blue, fin, and he sment of annual movements, monstrate (1) the occurrence excises in the offshore waters accessed in the offshore waters accessed to a calling whales, (3) the extension of the owed good forecasts for the owed good good forecasts for the owed good good forecasts for the owed good good good good good good good go	des via SOSU numpback when vironment and movem correlation correlation correlation core whale can be controlled the second correlation of the second	distribution unlimited  US hydrophones has continued to purchales across the North Pacific. The tal variability, and changes in call ents of calling components of the th Pacific, (2) the changes in these of calling with known features of Illing, and (5) tracks for individual ese strong biological noises.	rovide ese e calls,
12. DISTRIBUTION AVAILABILITY ST  13. SUPPLEMENTARY NOTES  14. ABSTRACT This seventh ye good data on the season data have allowed assess features. These data de populations of these specification activities, (4 whales. These have allowed assess the second of the season data have allowed assess features. These data de population activities, (4 whales. These have allowed assess the season data have allowed assess features. These have allowed as the season data have allowed as	Approved for publication of monitoring calling what had distribution blue, fin, and has ment of annual movements, monstrate (1) the occurrence ecies in the offshore waters access of calling whales, (3) the hannual patterns of offshowed good forecasts for the occurrence over the occurrence of the annual patterns of offshowed good forecasts for the occurrence of the occurrence of the occurrence of the annual patterns of offshowed good forecasts for the occurrence of the occurrence occurrence of the occurrence occurrence of the occurrence occu	des via SOSU numpback when vironment and movem correlation correlation correlation core whale can be controlled the second correlation of the second	distribution unlimited  US hydrophones has continued to purchales across the North Pacific. The tal variability, and changes in call ents of calling components of the th Pacific, (2) the changes in these of calling with known features of lling, and (5) tracks for individual ese strong biological noises.  A. NAME OF RESPONTING PRESON  William A. Wather and the control of the changes in the second control of the chan	rovide ese e calls,



## **Woods Hole Oceanographic Institution**

Woods Hole, Massachusetts 02543 USA Phone: (508) 548-1400

31 December 2002

Dr. Robert C. Gisiner, Code 341
Marine Mammal Science and Technology
Office of Naval Research
800 N. Quincy Street
Arlington, VA 22217-5660

Reference ONR Grant #N00014-02-10328

Dear Dr. Gisiner,

This is the final report for the work supported by ONR Grant #N00014-02-10328. The program of monitoring the calling whales across the North Pacific using U.S. Navy SOSUS and other systems has been highly successful. Thanks to ONR and SPAWAR, we've been able to complete another year of uninterrupted monitoring of the calling whales in the deep waters of the North Pacific, following the seasonal distribution of calling blue, fin, and humpback whales, as well as tracking a variety of other cetacean sound sources.

This is the seventh year of this program. The goal has been to describe the seasonal distribution of calling whales across the North Pacific over a long enough period to assess patterns of annual movements, species and environmental variability, and changes in call features. The focus has been on blue, fin, and humpback whales.

The result of the monitoring, has been robust measures of (1) the occurrence and movements of calling components of the populations of these three species in the offshore waters across the North Pacific, (2) tracking of changes in these calls, (3) estimates of numbers of calling whales, (3) correlation of calling with known features of population activities, and (4) repeated observations of the annual patterns of offshore whale calling. These have provided good forecasts for the occurrence these strong biological noises.

Our approach has been to use acoustic monitoring in the off-shore waters of the North Pacific. The sound data were analyzed from hydrophone arrays of the U. S. Navy's Sound Surveillance System (SOSUS) and any others that were available. The Navy data have been systematically monitored and analyzed at NOPF, Whidbey Is., WA, by operators (Joseph George and trained associates)

experienced in the operation of Navy sound processing systems and in identification of the whale calls. Calling whales have been monitored regularly over the last seven years during a rigid, consistent monitoring schedule over 16 hours on each of two, usually consecutive, days every week, centered on 1200 GMT to provide monitoring during both daylight and darkness across the Pacific.

Results of this monitoring continue to show the consistency of the whale seasonal distributions, different for each species. Blue whales calls are heard year-round, but with a strong seasonal peak in all regions occurring in the early fall from relatively scattered groups and individuals, particularly in the NW and NC regions. Fin whale calling is concentrated in mid winter from localized groups of whales occupying particular deep-water areas in the eastern and central regions, with no calling during the summer season. Humpback singing begins in winter in the NC and NE, moves to the SE region apparently with migration to and from southern waters, and then ends in spring back in NC waters. Environmental effects, such as from El Nino, were noted in the timing of blue whale calling, but not in fin or humpback sounds.

In addition to monitoring the seasonal variations in distribution of these calling whales, other whale sources have been monitored closely, including a unique "52-Hz" source that is likely a blue/fin hybrid tracked over ten seasons. Tracks for this whale for the ten years are attached (Figures 1-3) showing the variability from year to year as this whale seemingly emulates either blue or fin whale activities. Tracking of such sources demonstrates the potential reliability and detail of the passive acoustic systems for following the distribution and movements of calling whale populations.

Publications and reports of this work during this period:

Watkins, William A., and Mary Ann Daher. 2002 (monthly).

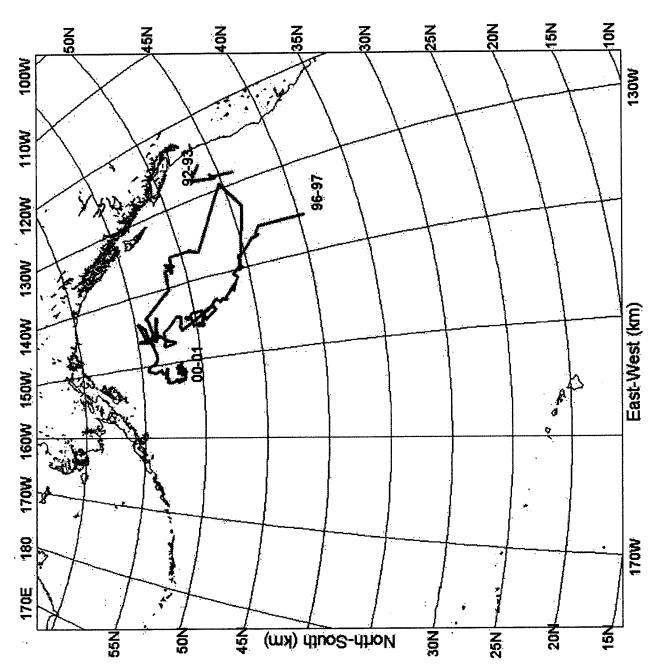
Whale calling in the North Pacific: comparison with previous years. Monthly Summary Reports for CNO/N45-ONR-NMFS-SPAWAR Analysis of Current Data on calling whales monitored at Whidbey Is. NOPF. Text 1 p., 12 pp graphic displays each. 12 unpublished Reports.

- Watkins, William A., Mary Ann Daher, and Joseph E. George. 2001. Numbers of calling whales in the North Pacific. Technical Report No. WHOI-2001-16, Woods Hole Oceanographic Institution, Woods Hole MA 02543, 37 pp.
- Moore, Sue E., William A. Watkins, Jeremy Davies, Mary Ann Daher, and Marilyn Dahlheim. 2002. Blue whale habitats in the Northwest Pacific: analysis of remotely-sensed data using a Geographic Information System. Oceanography 15(3): 20-25.
- Watkins, William A., Mary Ann Daher, and Joseph E. George. In press. Year to year variations in whale calling in the North Pacific. U.S. Navy Journal of Underwater Sound. Biologics Issue.
- Watkins, William A., Mary Ann Daher, Joseph E. George, and David Rodriguez. Submitted. Whale-like calls from unique 52-Hz source tracked over ten years in the North Pacific. Oceanography 21 pp.
- Watkins, William A., and Mary Ann Daher. 2002. Report of analysis of call type with geographic distribution for blue, fin, and humpback whales in the North Pacific. Unpublished report (showing no distinctions with distribution for fin and humpback whales, but distinct differences with region for blue whales, with "A" calls in the NW and NC regions and "AB" calls mixed with "A" calls in the NE and SE).

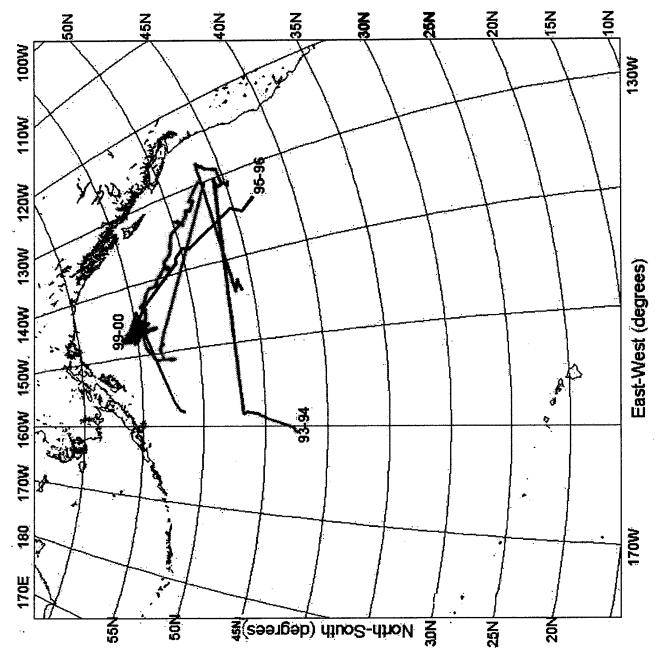
This has continued to be a very productive program, providing consistent, new, year-round data on the seasonal distribution and movements of the calling whale populations of the deep waters of the North Pacific basin.

Sincerely,

Mm. A. Matséins William A. Watkins



Meandering (A) Tracks



West-East (B) Tracks

